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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application Number: 10/790,457
Filing Date: March 01, 2004
Appellant(s): PAWLOSKI ET AL.

Thomas W. Adams

For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed 09/17/2007 appealing from the Office action mailed 07/16/2007.

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The statement of the status of claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct.

(6) Grounds of Rejection to be Reviewed on Appeal

The appellant's statement of the grounds of rejection to be reviewed on appeal is correct.

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

6024801	Wallace et al.	02-2000
6612317	Costantini	09-2003

Switkes et al., "Immersion Lithography at 157nm", J. Vac. Sci. Technol. B 19(6), Nov./Dec.2001, pp. 2353-2356.

Examiner notes that Appellant has provided evidence, which is not directly pertinent to the claims on appeal that was used to overcome the initial rejection in the office action mailed 11/09/2006, which was withdrawn.

(9) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claim Rejections - 35 USC § 103

2 The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

3. The factual inquiries set forth in *Graham* v. *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

4. Claims 1-6, 8-13, 15-21 and 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Switkes et al in view of Wallace ('801) and further in view of Costantini ('317).

Examiner submits that Costantini ('317) provides a general teaching, which demonstrates it is known in the art to recover fluids and other materials from a semiconductor wafer process, which are purified to a purity suitable for recycling and reuse in the semiconductor wafer process. (See, Costantini, col.6, 6-56). Moreover, Examiner submits that while Costantini ('317) does not explicitly disclose that the "effluent" stream recovered is immersion fluid or comprises immersion fluid, nevertheless the combined teachings of the references render Appellants' claims obvious.

The recitations of Costantini ('317) and the recitations of Appellants claims are directed to semiconductor wafer processing. Moreover, the teachings in Costantini ('317) and the recitations of Appellants' claims are directed to recovering, purifying and recycling fluid materials that are used in processing a semiconductor wafer. In Appellants' claims the fluid recovered is immersion lithography medium and other particulates cleaned from the wafer surface using supercritical CO_2, in Costantini ('317) the fluid is "effluent" that includes the fluid materials used in the process and loose particulate materials removed with the effluent from the surface of the wafer. (See, col.6, 6-18).

In Appellants' claims and the teachings of Costantini ('317) the fluids are subjected to a purification process, which allows the fluids to be recycled back to the respective semiconductor wafer processes. Costantini ('317) applies well-known separation process steps that includes passing the effluent stream into a separation apparatus or reboiler, where the steam is separated into vapor and liquid phase streams based on the conditions in the reboiler. (See, col.6, 6-56). The liquid stream, which comprises co-solvent and other contaminants, is then passed into a second reboiler from which a vapor phase stream is produced of co-solvent that is suitable for recycling for reuse to the wafer processing chamber. (See, col.6, 6-56). One of ordinary skill in the art would understand that suitable purity for a semiconductor wafer process would require that the recycled material

Switkes et al describes a study on the feasibility of immersion lithography at 157nm, which is a limitation recited in claims 5 and 10 and is within the range recited in claim 4. (See, abstract). In this study a class of commercially available liquids such as perfluoropolyethers are identified as good candidates as an immersion lithography medium, which meets the limitation of claims 2, 11 and 17. (See, abstract). Switkes et al goes on to disclose that the perfluoropolyethers are a good immersion lithography medium because they are transparent, optically clean, chemically inert and compatible with some current resist materials, which meets the limitations of claims 3, 12, and 16 where the immersion lithography medium is non reactive with the material on the surface of the semiconductor wafer and is substantially transparent to radiation. (See, Section II. pg. 2353; 2355).

Switkes et al also describes performing an immersion lithography process. Thin layers of resist are spun on a Si substrate and then baked. The substrate was then covered with a thin layer of immersion fluid and then exposed. Next a low molecular weight solvent was used to remove the immersion liquid. After removing the wafer was subjected to a post exposure bake, followed by a developing step in a TMAH solution. (See, Section III. Pg. 2355). This disclosure meets the limitations of claims 1, 10 and 16 where an immersion lithography medium is applied to the surface of semiconductor wafer and the material on the surface of the wafer is exposed to electromagnetic radiation, as well as the limitation of claims 9-10 and 16 where the material layer on the wafer is exposed through the immersion lithography medium. This disclosure also meets the limitation of claims 6, 13 and 18.

Switkes et al fails to disclose a step of applying supercritical CO_2 to the wafer to remove the immersion lithography medium from the surface of the wafer; however, Wallace discloses such a process step.

Wallace ('801) claims a method of processing a wafer comprising the steps of: placing the wafer have a wafer surface in an enclosed and controlled environment; exposing said wafer surface to a cleaning medium rendered as a supercritical fluid; purging said environment of substance including soluble chemical compound liberated from said wafer surface by said cleaning medium. (See, claim 19). Wallace ('801) also discloses an example in which the supercritical fluid used is carbon dioxide. (See, col.8, 31-42). Wallace ('801) further discloses that removal of a material such as a fluorocarbon from the surface of a wafer could be facilitated by exposure to UV light during the exposure of the wafer to supercritical CO_2. These teachings in Wallace ('801) meet the limitation of claims 1, 10 and 16 where supercritical carbon dioxide is applied to a semiconductor wafer to remove immersion lithography medium from the surface of a semiconductor wafer.

Still, Switkes et al in view of Wallace ('801) fails to disclose the limitations of claims 1, 10 and 16, where after supercritical CO_2 is applied to the surface of the wafer a mixture of immersion lithography medium and supercritical CO_2 is removed from the surface, and the immersion lithography medium is recovered from the mixture and purified. Moreover, Switkes et al in view of Wallace ('801) fails to disclose the limitation of claims 8, 15 and 19 where the immersion lithography medium is recovered by reducing the temperature or pressure of the mixture to remove CO_2 from the mixture. Switkes et al in view of Wallace ('801) also fails to disclose that the recovered immersion lithography medium will exhibit the same chemical composition or the same purity as the lithography medium applied to the surface of the wafer as recited in claims 20-21 and 23, as well as the limitation of claims 10 and 23, where the purified immersion lithography medium is recycled. However, these limitations are taught in Costantini ('317).

Costantini ('317) discloses a supercritical fluid delivery and recovery system for semiconductor wafer processing. (See, col. 2, 7-11). In this method there is a recovery section (See,

col. 3, 24-31) that takes in a solvent, which is a mixture of immersion fluid and supercritical CO_2, referred to as effluent, obtained from a semiconductor processing chamber. (See, col.6, 6-18). This disclosure teaches the limitations of claims 1, 10 and 16, where a mixture of the immersion lithography medium removed from the surface and the carbon dioxide is recovered. The recovery section functions to collect, separate and purify the by-product gas, the co-solvent and other contaminants in the effluent and then return them to their respective receiver tanks or discharge as waste, which meets the limitations of claims 1, 10 and 16 where the immersion lithography medium that is recovered and purified and the limitation of claims 10 and 23 where the immersion lithography medium is recycled. (See, col.4, 1-10).

Costantini ('317) further discloses that in the recovery section the effluent passes into a separator where pressure and temperature fall below the critical points and the effluent separates into a vapor phase and a liquid phase. (See, col.6, 21-25). This disclosure teaches the limitations of claims 8, 15 and 19. The vapor phase contains the gas or gas mixture originally supplied into the feed portion of the system. The liquid phase contains the solvent and any other suspended components still remaining, and it is passed into a separator and heated to its boiling point. Then the solvent is separated as a vapor back to a suitable purity to be reused in the semiconductor wafer process chamber. (See, col. 6, 29-56). Although, Costantini ('317) does not specify a purity for the recovered immersion fluid, it is inherent that "suitable for re-use" means the recovered fluid would exhibit the same chemical composition or purity as the immersion fluid applied to the surface of the wafer as recited in claims 20-21 and 23.

It would have been obvious to one of ordinary skill in the art at the time of invention by applicant to modify the teachings of Switkes et al in view of Wallace ('801) and further in view of Costantini ('317), in order to recover the immersion lithography medium that is removed by

applying supercritical CO_2 to the wafer, because Wallace ('801) teaches that supercritical fluids such as supercritical CO_2 can be use to remove substances such fluorocarbons from the surface a semiconductor wafer, and Costantini ('317) teaches that one can recover and then purify effluent from a semiconductor wafer processing chamber in order to recycle the immersion lithography medium that is recovered back to the semiconductor wafer processing chamber for re-use, resulting in a more economically efficient semiconductor wafer processing method.

(10) Response to Argument

A. Appellants' Claims 1-6, 8-13, 15-21 and 23 are obvious over Switkes et al. in view of Wallace (US 6024801) and further in view of Costantini (US 6612317) because the combined references do teach and or suggest all the claims features.

Appellants argue that while the combined references do disclose some of the features of their invention the references fail to disclose or suggest all of the claimed features. Appellants argue that Costantini ('317) fails to disclose recovering and purifying and/or recovering, purifying and recycling for reuse in immersion lithography, the immersion lithography fluid. Appellants further argues that while Wallace ('801) does relate to the use of supercritical fluids such as carbon dioxide to remove substances from nascent semiconductor wafer, it has nothing to do with immersion lithography because it does not mention lithography; therefore, Wallace ('801) is irrelevant to the present invention, except for it use of supercritical carbon dioxide to clean a surface.

Examiner submits that Switkes et al. discloses an immersion lithography process which teaches the process steps recited by applicant, except for the step of cleaning of the wafer surface with supercritical carbon dioxide and the step of recovering, purifying and/or recycling the immersion lithography fluid. Wallace ('801) is then relied on in the rejection for teaching the removal of substances from a nascent semiconductor wafer using supercritical fluids such as carbon dioxide.

While Wallace ('801) may not disclose that the materials removed from the wafer is immersion fluid, the teachings in Wallace ('801) are nevertheless relevant because the disclosures in Wallace ('801) provide a general teaching that substances such as fluids and/or particulate materials can be removed from a semiconductor wafer using supercritical carbon dioxide (CO_2). (See, Wallace ('801) col.8, 31-42; claim 19). Wallace ('801) discloses that supercritical CO_2 is used for cleaning because it is recognized in the art that supercritical CO_2 effectively removes liquids from surfaces that are stuck by liquid-solid forces because supercritical CO_2 drying solves the surface tension problem that caused the liquid materials to stick to the surface of the wafer. (See, col.4, 18-28). Therefore, Wallace ('801) is relevant prior art and it does cure the deficiency of Switkes et al., which fails to teach a step of cleaning the wafer after processing using supercritical fluid such as carbon dioxide.

Examiner would further submit that Costantini ('317) does cure the deficiencies of Switkes et al. in view of Wallace ('801), because Costantini ('317) teaches recovering fluid materials from a semiconductor wafer process, purifying the recovered fluid materials and recycling the fluid materials back to the process at the same purity as it was introduced to the process. (See, Costantini ('317) col.6, 6-56). Although Costantini ('317) does not teach that the "effluent" recovered from the wafer processing chamber is immersion fluid the disclosures of Costantini nevertheless do teach and/or suggest such a process step as recited in Appellants' claims.

Foremost, the disclosures of Costantini ('317) teach and/or suggest that fluids used in a semiconductor wafer processing chamber can be recovered, purified and then recycled back to the process chamber using well-known separation processes. (See, col.6, 6-56). Moreover, Costantini ('317) provides that materials recycled back to the process chamber are purified to a suitable purity for recycling back to the semiconductor wafer process. (See, col.6, 6-56). One of ordinary skill in the art would understand that suitable purity for recycling to a semiconductor wafer processing chamber

requires that the materials be of the same purity as originally used in the process because of the well-known sensitive nature of semiconductor wafer processing.

Lastly, the teachings of Costantini ('317) demonstrate that recycling of fluid materials recovered from the semiconductor wafer process chamber, results in a more economically efficient semiconductor wafer processing method. Therefore, one of ordinary skill in the art would be motivated to modify the teachings of Switkes et al. in view of Wallace ('801) further in view of the teachings of Costantini ('317).

Therefore, Examiner maintains that the combination of references, do teach and/or suggest all the limitations of claims 1-6, 8-13, 15-21 and 23. Therefore claims 1-6, 8-13, 15-21 and 23 are obvious over Switkes et al. in view of Wallace (US 6024801) and further in view of Costantini (US 6612317) and the rejection should be sustained.

B. Costantini ('317) does not fail to teach and/or suggest recovery and purification for re-use of the immersion lithography fluid.

Examiner submits that although Costantini ('317) does not teach that the "effluent" recovered from the wafer processing chamber is immersion fluid or comprises immersion fluid the disclosures of Costantini ('317) nevertheless do teach and/or suggest such a process step as recited in Appellants' claims.

Foremost, the disclosures of Costantini ('317) teach and/or suggest that fluids used in a semiconductor wafer processing chamber can be recovered using a supercritical fluid, purified and then recycled back to the process chamber using well-known separation processes. (See, col.6, 6-56). The separation of the effluent stream into a vapor phase and a liquid phase depends upon the conditions in the separator. (See, col.6, 6-56). Costantini ('317) teaches that the liquid phase stream is passed into a second reboiler where the co-solvent is then separated into a vapor phase at a suitable

purity to be reused in the semiconductor manufacturing process and a liquid stream that contains any remaining contaminants. This vapor phase stream is condensed and recycled to the wafer processing chamber. (See, col.6, 6-56).

These disclosures in Costantini ('317) provides a teaching that encompasses the process step in Appellants' claims where the immersion lithography fluid is recovered from the wafer using supercritical CO_2, is purified and is then recycled to the wafer for reuse. Furthermore, one of ordinary skill in the art would understand from the disclosure in Costantini ('317) teaching that the materials are purified to a suitable purity for recycling to the semiconductor wafer processing chamber, that the materials are of the same purity as originally used in the process because of the well-known sensitive nature of semiconductor wafer processing.

Therefore, the disclosures of Costantini ('317) do teach and/or suggest the limitations of Appellants' claims where the immersion fluid is recovered from a semiconductor wafer processing chamber, is purified to the same purity as when introduced into the process, and then recycled for re-use in the process chamber.

C. Claim 23 is obvious over the combined references

Examiner submits that claim 23 is obvious over the combined references because the combination of references do teach and/or suggest the limitations of Appellants' claim 23 where the immersion medium recovered from the mixture and purified exhibits the same purity as the medium applied to the surface of the semiconductor wafer, and is then recycled for reuse in the immersion lithography process. The combination of references provides teachings, which demonstrates that the process steps of claim 23 are well known in the art, and that it would have been obvious to one of ordinary skill in the art to recycle materials back to a semiconductor processing chamber by purifying the materials to a suitable purity for reuse to promote economic efficiency.

Switkes et al. disclose an immersion lithography process having the process steps recited by Appellants, except for the step of cleaning the wafer surface with supercritical carbon dioxide and the step of recovering, purifying and/or recycling the immersion lithography fluid, such as recited in claim 23. Wallace ('801) cures the deficiency of Switkes et al., by teaching a step of cleaning a semiconductor wafer after processing using supercritical fluid such as carbon dioxide. (See, col.8, 21-42; claim 19).

Costantini ('317) then cures the deficiency of Switkes et al. in view of Wallace ('801) by providing teachings that materials recovered from a semiconductor wafer in a processing chamber can be purified and then recycled back to the semiconductor wafer process. (See, col.6, 6-56). Although Costantini ('317) does not teach that the "effluent" recovered from the wafer processing chamber is immersion fluid, one of ordinary skill in the art would appreciate that the general teachings of Costantini ('317) would also encompass the limitations of claim 23. Lastly, it must be noted that the combination of references is not only applicable for what is explicitly disclosed, but also for what one of ordinary skill in the art would understand is implicitly disclosed. The implicit disclosure is found in the teachings of Costantini ('317) which demonstrates that it is known in the art to recover fluid materials used in processing a semiconductor wafer and then to purify the fluid material recovered to a purity that is suitable for recycling the fluid material back to the wafer processing chamber for reuse.

Therefore, claim 23 is obvious in view of the combination of Switkes et al., Wallace ('801) and Costantini ('317) and the ground of rejection which encompasses claim 23 should be sustained.

D. The arguments of the Examiner in the Final Office Action and Advisory Action are not based on Incorrect "Fact", an Overbroad Reading of the References nor do the arguments fail to credit all the features of Appellants' claims.

exhibit the same purity as when initially introduced into the processing chamber because of the sensitive nature of semiconductor wafer processes.

Examiner submits that Appellants' have unduly limited the scope of the combined teachings of Switkes et al., Wallace ('801) and Costantini ('317). Appellants contend that because Costantini ('317) does not explicitly teach that the "effluent" recovered from the wafer processing chamber is or comprises immersion lithography medium the combination of references fails to teach and/or suggest all the limitations of claims 1-6, 8-13, 15-21 and 23. However, it must be noted that the rejection of claims 1-6, 8-13, 15-21 and 23 is an obviousness rejection over the combination of the teachings in Switkes et al., Wallace ('801) and Costantini ('317). Moreover, it must be noted that the references are not only applicable for what is explicitly disclosed but also what is implicitly disclosed. The implicit disclosure is found in the teaching of Costantini ('317) which demonstrates that fluid materials used in a semiconductor wafer process can be recovered, purified to a suitable purity for reuse and then recycled to the semiconductor wafer process for reuse.

Examiner maintains that appropriate breadth has been given to the teachings of the combination of the references, and that the teachings of the references have been appropriately interpreted and applied to Appellants' claimed invention. Therefore, the rejection of claims 1-6, 8-13, 15-21 and 23 is proper over Switkes et al. in view of Wallace ('801) further in view of Costantini ('317) and the rejection should be sustained.

(11) Related Proceeding(s) Appendix

No decision rendered by a court or the Board is identified by the examiner in the Related Appeals and Interferences section of this examiner's answer.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

Examiner Caleen O. Sullivan

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